UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

Testing Guidelines (Protocol) for ENERGY STAR® Qualified Set-Top Boxes
July 2000

This protocol should be followed to ensure consistency in measuring the power requirements for ENERGY STAR® qualified set-top boxes. Outlined in Section I are the ambient test conditions that should be respected when performing power measurements. These conditions ensure that outside factors do not affect the test results and that the test results can be reproduced. Sections II and III describe the specifications for testing equipment and the test method, respectively. Section IV reviews responsibilities, while Section V covers continuing verification. Questions and Answers complete this document.

I. TEST CONDITIONS

General Criteria:

Total Harmonic Distortion (Voltage):	< 3% THD
Ambient Temperature:	22ºC ± 4 ºC

Terminations: External speaker terminals terminated per 3.6.2.2 (IEC 107-1)

Market-Specific Criteria:

Market:	**United States**	**Europe and Australia**	**Japan**
Voltage:	115 V RMS ±3 V RMS	230 V RMS ± 10 V RMS	100 V RMS ± 5 V RMS & 200 V RMS ± 10 V RMS
Frequency:	60 Hz ± 3 Hz	50 Hz ± 3 Hz	50 Hz ± 3 Hz & 60 Hz ± 3 Hz

Note: Testing needs to be done only at a voltage and frequency in the above range. It is not necessary to test all combinations of high voltage/low frequency, high voltage/high frequency, etc.

ENERGY STAR is a registered U.S. mark.

II. TEST EQUIPMENT

Manufacturers should measure and report the true standby/low-power mode[1] requirements of the product. Doing so necessitates the use of a true power watt meter. Because there are many watt meters from which to choose, manufacturers need to exercise care in selecting an appropriate model. The following items should be considered when procuring equipment and performing the test:

1. AC Power Source (with sufficient output current for the test unit such that it meets the requirement for AC line voltage, frequency stability, and THD).
2. True Power Meter (with sufficient accuracy, resolution, crest factor rating, and bandwidth).
3. Oscilloscope with Current Probe (to monitor AC line current waveform, amplitude, and frequency. Optional but recommended).
4. True RMS Volt Meter (to verify voltage at the input of test unit. Optional if AC source output is sufficiently accurate).
5. Frequency Counter (to verify frequency at the input of test unit. Optional if AC source output is sufficiently accurate).

Crest Factor

Electronics equipment may draw current that is not sinusoidal.[2] While virtually any watt meter can measure a standard current waveform, it is more difficult to select a watt meter when irregular current waveforms are involved.

It is critical that the watt meter selected be capable of reading the current drawn by the product without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a review of the meter's crest factor rating and the current ranges available on the meter. Better quality meters will have higher crest factor specifications and more choices of current ranges.

To determine the crest factor rating requirement of the meter and the proper current range settings, the peak current (amps) draw of the product under test in standby/low-power mode must first be measured. This can be accomplished using an oscilloscope with a current probe.

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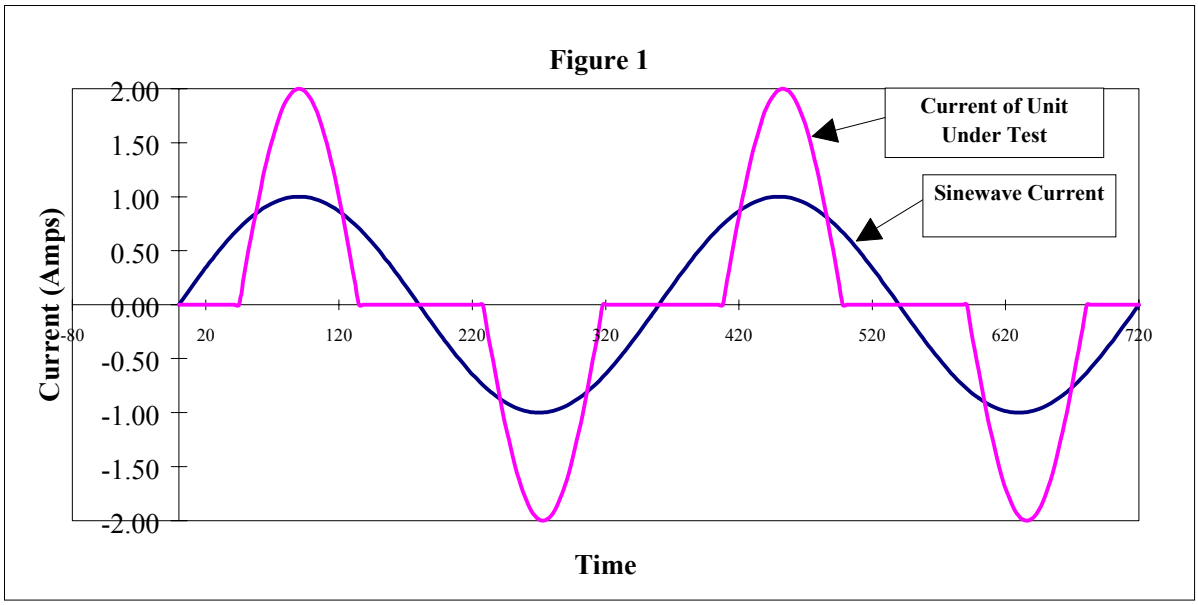
[1] True power is defined as (volts)x(amps)x(power factor) and is typically reported as watts. Apparent power is defined as (volts)x(amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0; therefore, true power is always less than apparent power.

[2] The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps). The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with a product containing a switching power supply will always be greater than 1.4 (though typically no higher than 8).

A current range on the meter must be selected that is sufficient to register the peak current. Specifically, the full-scale value of the selected current range multiplied by the crest factor of the meter (for current) must be at least 15% greater than the peak current reading from the oscilloscope to compensate for any measurement error. (Note: It is difficult to measure within 5% using an analog oscilloscope.) For example, if a watt meter has a crest factor of 4 and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If measured peak current is only 6 amps, the meter would be satisfactory. If, however, the current range is set too high, the meter may lose accuracy in measuring non-peak current. Therefore, some delicate balancing is necessary. When choosing a meter, make sure that the crest factor is given for the current level that you desire.



Frequency Response

Another issue to consider when selecting a watt meter is the frequency response rating of the meter. Electronics equipment may cause harmonic waveforms that can lead to inaccuracies in the power measurements. For example, electronics equipment powered by switching power supplies typically produces odd harmonics up to the 21st. To ensure that the harmonics are properly addressed, EPA recommends the use of a watt meter with frequency response of at least 3 kHz. This will account for harmonics up to the 50th, which is recommended by IEC 555.

Resolution

Manufacturers should choose a watt meter that can provide resolution of 0.1 watt.

Accuracy

Catalogues and specification sheets for watt meters typically provide information on the accuracy of power readings that can be achieved at different range settings. If the power measurement is very close to the energy-efficiency guideline specified in the MOU, a test procedure with greater accuracy will be necessary. For example, if the ENERGY STAR specification is 1.0 watt or less *and* the resulting accuracy of the watt meter at the test settings is ± 0.1 watts, then a power measurement of less than 0.9 watts will ensure that the product is compliant.

Calibration
To maintain their accuracy, watt meters should be calibrated every year with a standard that is traceable to the U.S. National Bureau of Standards (NBS).

III. TEST METHOD

Following are the test steps for measuring the true power requirements of the test unit in standby/low-power mode:

1. Power on all test equipment and properly adjust operation range.

2. Connect the test equipment and unit under test.

3. Check for normal operation of the test unit and leave all customer adjustment to factory default settings (i.e., unit must be in the condition shipped to the customer). In addition, if a product is designed for a network environment, it must be tested while connected to the network to ensure that all power consumption and performance criteria are met.

4. Bring the test unit into standby/low-power mode (not disconnect mode) either by using the remote control device or by using the ON/OFF switch on the test unit cabinet.

5. Either verify that the wall outlet power is within specifications or adjust the AC power source output as described in Section I (e.g., 115Vrms ± 3Vrms, 60Hz ± 3Hz).

6. Set the power meter current range. The selected full scale value multiplied by the crest factor rating (Ipeak/Irms) of the meter must be greater than the peak current reading from the oscilloscope.

7. After the unit under test reaches operating temperature and the readings on the power meter stabilize (approximately 90 minutes), take the true power reading in watts from the power meter.

8. Record the test conditions and test data. The measurement time shall be sufficiently long to measure the correct average* value to within a +10% - 0% error. If the device has different standby/low-power modes that can be manually selected, the measurement should be taken with the device in the most power consumptive mode. If the modes are cycled through automatically, the measurement time should be long enough to obtain a true average that includes all modes.

*** The power consumption measurement will be continued for 24 hours and averaged or until the time period where averaged power consumption can be accurately measured. The time period for testing an individual model is based upon its standby/low-power mode consumption profile.**

Example 1: A unit under test [UUT] has modes that every 10 minutes put it into a low-power state for 9 minutes and a higher power state for 1 minute. An average over 10 minutes will be sufficient to capture the true average power consumption of the device.

Example 2: The UUT has complex modes that put it in a low-power state for 4 hours and an alternating high-low power state for 1 hour. An average over 5 hours will be sufficient to capture the true average power consumption of the device.

IV. RESPONSIBILITIES

EPA's testing guidelines are not mandatory, but they will be distributed to outside parties such as buyers and the press. Following these guidelines and producing accurate test results will assist manufacturers in making products compliant with the MOU. Companies may determine the appropriate level of stringency and accuracy for their own testing based on their specific products.

V. CONTINUING VERIFICATION

This testing procedure (protocol) describes the method by which a single unit may be tested for compliance. An ongoing testing process is highly recommended to ensure that products from different production runs are in compliance with the MOU. A model may qualify as ENERGY STAR if testing indicates that 95% of the units sold under this model name/number will meet the specifications contained within the MOU.

Questions and Answers Regarding Testing Procedures
For ENERGY STAR® Qualified Set-Top Boxes

Q: Where can I find AC Power Source Equipment?

A: An AC Power Source can be ordered from several manufacturers, including Pacific Power, California Instruments, Elgar, and Kikusui.

Q: Where can I find a true watt meter that will meet my requirements?

A: A true watt meter can be ordered from several manufacturers. The EEM catalogue lists approximately 75 companies under "Meters, Watt." Perhaps only one-third of these companies makes meters suitable for ENERGY STAR measurement. Manufacturers carrying watt meters that may be appropriate include AEMC, Clarke-Hess, NGI-Norma, Ohio Semitronic, Valhalla, Voltech, and Yokogawa. When contacting these manufacturers, please indicate how the equipment will be used and request specification sheets. (As you find adequate meters, please let EPA know so we can share this information with other partners.)

Q: Can I send my products to an outside laboratory for testing?

A: Yes. ENERGY STAR allows manufacturers to submit products to an outside laboratory for compliance testing. A good test lab should be aware of the issues surrounding power measurement for electronic devices, but do not assume this is the case. You will probably want to offer the testing lab copies of the Testing Guidelines (Protocol) for ENERGY STAR® Qualified Set-Top Boxes.

Q: Can I assume that the voltage coming out of my wall socket is close to 115 V?

A: While your wall socket voltage may be acceptable, do not assume that it is. The voltage coming out the wall could easily vary by more than ± 5 V from the suggested 115 Volts AC.

Q: If I do not have access to an AC power source, what else can I do to get an acceptable AC power source for testing?

A: If the THD and frequency are acceptable, you can use a low cost autotransformer to adjust the line voltage to the correct value. If you also need to correct the THD, you can use a "resonant" line voltage regulator between the wall outlet and the device under test. The input voltage can then be regulated to 115 V ±3V.

Q: Will the voltage coming out of the wall have a harmonic distortion less than 5% THD?

A: Not always. You can use an AC power source to correct the THD. Alternatively, a "resonant" line voltage regulator will help regulate distortion to within 3%, thereby achieving less than 5% necessary for the test conditions. Before you use a resonant transformer, make sure that it can handle the peak currents while still maintaining the voltage, frequency, and THD limits of the specification.

Q: Are these testing guidelines mandatory?

A: These testing guidelines are not mandatory, but stringency in testing is to your firm's advantage. It can help protect you from accusations of noncompliance by your competitors or others. The stringency and accuracy of your own testing may be determined on the basis of your specific product. For example, if your product measures well below the ENERGY STAR specifications with a sufficient margin to account for any accuracy errors, the accuracy and frequency of the tests will not be as critical. However, if your product measures close to the ENERGY STAR specifications, it is best to follow these guidelines as strictly as possible. A model may qualify as ENERGY STAR if testing indicates that 95% of the units sold under this model will meet the specifications contained within the MOU.